NATURAL GAS.

I.

WHAT IS IT?

Natural gas has been the subject of much thought and discussion in Indiana during the two years just past, and, as might have been expected, under the pressure of popular excitement, much of the work done with a view to develop the facts in connection with the discussion has been ill-directed and generally futile.

The discovery of gas at Findlay and at other points in North western Ohio created a furor for well-boring, which ran all over Indiana, and the drill began its work at whatever point money was to be had to pay for the expensive operation. The consequence has been a loss to the citizens of Indiana of many thousands of dollars. The State Geologist was not consulted, save in two or three instances where work had already been begun. Everybody took it for granted that because Ohio had great reservoirs of subterraneous gas Indiana also possessed them, whereas it is true that of wells bored but a short distance apart, even in the best areas of the Ohio gas region, some are successful while others are utter failures. The reason for this will clearly appear when some of the leading facts are considered. It is the purpose of this paper to set before the people of Indiana, in the plainest way, a sketch of the substance of what has been discovered in relation to the nature, the origin and the mode of accumulation and retention of na ural gas in the rocks of the earth.

Natural gas has for its chief constituent carbureted hydrogen, or marsh gas, which amounts, speaking generally, to about ninety-three per cent. of the whole substance in the case of the gas found nearest us in the State of Ohio, the remaining seven per cent. being made up of nitrogen, hydrogen, carbonic acid, oxygen, carbonic oxide and sulphureted hydrogen, with quantity graduated in the order named.

Professor Howard, of Columbus, furnished Professor Orton, State Geologist of Ohio, to whom I am greatly indebted for many facts, the following analysis of the gas from the celebrated Findlay wells:

Marsh gas (light carbureted hydrogen)	92.61
Olefiant gas	0.30
Hydrogen	2.18
Nitrogen	3.61
Oxygen	0.34
Carbonic acid	0.50
Carbonic oxide	0.26
Sulphureted hydrogen	0.20

Of course such a gas is highly combustible and possesses great heating power upon being ignited. So far the discovery of natural gas has shown it to be associated with deposits of petroleum or with rocks in which petroleum might reasonably be looked for upon scientific principles; this, together with the chemical composition of the gas substance, supports the assumption that petroleum and natural gas come from the same source, and that they are, in some way, the result of the chemical decomposition of organic matter chiefly vegetable.

There has been a great deal of fine-spun theorizing upon this subject which might well give place to a practical collating and analyzing of facts.

Nearly all the conditions which point to a vegetable origin for fossil coal affect both petroleum and natural gas, as will be better understood by keeping it in mind that oil and gas are able to travel through passages in the rocks under ground, while coal must remain in the place where first deposited. It is because oil and gas have flowed readily, and, perhaps, to great distances under favorable circumstances, through subterraneous channels, that we can not always trace them to a local source. It is very significant, however, that, as a rule, any strong and persistent stream of natural gas will not be far from deposits of petroleum in the same, or practically the same, horizon, or it will be found so situated that it may be traced to the same rocks for its source.

There are many facts tending to prove that petroleum and gas are, in a degree, indebted for their substance to the chemical destruction of animal matter, but the larger facts point to a vegetable origin, and some of our profoundest scientists have suggested the existence during the Silurian age of a sargasso sea which furnished the organic matter. Such a suggestion carries with it the explanation of how animal organisms, such as marine shell-fish, could have added their part to the petroleum of the sedimentary rock forming at the bottom of the water.

It has been demonstrated that a substance practically identical with petroleum can be extracted chemically from vegetable matter, and the existence of paraffine in both vegetable matter and rock oil is a significant fact in this connection when we consider the constitution of hydrocarbons.

It would not be profitable to enter into a discussion of the many theories advanced by scientists of high standing to account for the existence of

petroleum and gas in the body of the rocks. Suffice it to say that all the evidence appears to me quite conclusive that, in the first place, the gas and oil come from the same source—that they are separate and distinct manifestations of the chemical destruction of vegetable and animal organisms; and, in the second place, that they are the results, each of a different stage, of the decomposition of those organisms. In short, the theory that natural gas is generated deep in the bowels of the earth from superheated water coming in contact with metallic oxides is extremely fanciful, and has no observed facts for its basis.

In answer to the question, then, What is natural gas? we may say that it is, in substance, marsh gas slightly charged with impurities, and that it has been derived, just as marsh gas now is, from the decomposition of carbonaceous matter, mostly vegetable.

II.

WHERE IT IS FOUND.

Petroleum is found in nearly or quite all the paleozoic rocks. What is called by drillers "oil sand" is, generally speaking, a porous limestone, whose interstices are filled with the fluid; but the substance is found throughout the limestone formations in "pockets," or hollows, varying in size from mere infinitessimal cavities to large reservoirs. In the shales, too, bituminous matter is plentifully distributed.

Gas is always present in the oil-bearing rocks, its amount being controlled by certain laws not yet thoroughly understood.

The lightness of gas causes it to seek a higher level than that of water or that of oil, consequently it will occupy the highest reservoir open to it under ground, so that, in boring for it, it may be reached in a position far removed from the place of its origin. Indeed, the very nature of a light gas would require force to confine it at a low level; as, for instance, at the bottom of a synclinal. Hence we should most naturally expect to find it under the crown or along the slope of an anticlinal. We might safely assume that, just as water generated at the crown of an anticlinal would flow down to the lowest point of the adjacent synclinal, gas generated at the bottom of a synclinal would follow any porous stratum thence to the highest point of the anticlinal. Hence all the great subterraneous reservoirs of gas are to be found in localities where the strata have been disturbed by shrinkings of the earth's crust. No thoroughly successful gas wells have been made in low synclinals. In Ohio, Professor Orton has shown that where gas is found in the Trenton limestone the horizon is never lower than 500 feet below the sea level. It is worth noting in this connection that in some places where the Trenton rock has

failed to yield oil or gas a strong flow of artesian water has been secured. Here is a suggestion of hydrostatic power supplied by nature for forcing oil up to the levels far above its source of production. When more shall be found out than is now known about the structure of the deep-lying rocks of Ohio and Indiana a law may be discovered governing the rising and accumulation of gas in the porous strata along slopes and anticlinals, and I feel sure that what may be phrased as artesian pressure will prove to be a large factor in the process.

The force exerted by the gas in some of the greatest wells is enormous, amounting in some instances to a pressure of several hundred pounds to the square inch.

Gas, in available quantities, has been found in various geological horizons, but those valuable wells which are nearest to Indiana in Ohio have their source in the Trenton formation of the Lower Silurian. The rock, as described by Professor Orton, is a porous magnesian limestone and not an oil or gas sand at all. It lies below from two to three hundred feet of Utica shales which form an impervious clayey roof.

The region of the Ohio wells is one showing marked disturbances of the rock strata in the form of slight folds or waves. The oil and gas are gathered in the anticlinals, or in the higher parts of the porous stratum. The series of troubles or disturbances of the paleozoic rocks noted by Professor Orton in Northern Ohio has been traced by my survey across Indiana into Illinois, and is described in another paper. It would, therefore, appear possible, if not strongly probable, that gas and oil may be found at some point in our northern area. One may not speak with assurance pro nor con, but with the light at hand it is safe to say that there is much to encourage confidence in the successful outcome of boring, as regards finding oil or gas in paying quantities, and the reward of success in boring is so great that even a bare possibility is worth risking the expense on, especially where the work is done upon the system of local subscription so generally followed in such cases. Furthermore, structural accidents in the rock formations must necessarily be regarded as an element in all our calculations in this connection, and the evidence of these accidents is often so hidden by the Drift deposits over a large part of Indiana that boring is, after all, the only perfect road to discovery.

In answer, therefore, to the question, "In what areas of Indiana is the finding of oil and gas in valuable quantity most to be expected?" I may safely say: The northern part and the south-western part may be examined with much confidence, though it is quite possible that extensive reservoirs exist in other areas of the State.

III.

"SURFACE SIGNS" AND OTHER EVIDENCES OF WHERE TO BORE FOR OIL OR GAS IN INDIANA.

The following facts must be understood and be kept well in memory while exploring for oil or gas:

Oil has been found, in varying quantities, throughout the paleozoic rocks.

Gas has been found in all the rocks above and including the Lower Silurian, small "pockets" or cavities full of it having been discovered in the body of the glacial Drift and in the compact recent clayey and peaty deposits.

Wherever carboniferous shales are exposed there may be found evidences of the escape of oil and gas from the body of the formation. So in limestones, and even in the central cavity of geodes, a thick, rich rock-oil may be seen. From marshy places and from springs of water a light gas is often found rising, sometimes accompanied by a natant film of oil on the surface of stagnant pools. These so-called "surface signs" are rarely significant of any deposits or accumulations of gas or oil worth developing. In the case of marshy spots the source of gas generation may be and usually is very near the ground surface and will be found in submerged vegetable matter. In the Drift formation the gas source is often obscure, but facts enough have been observed and recorded to make it clear that in this case, too, the generation is brought about by the decomposition of rafts of wood or other plant matter buried during some of the glacial or post-glacial disturbances of the mass. Bituminous shales and other carboniferous deposits of a like character probably have received their oily and gas bearing character from both vegetable and animal substances deposited along with their other constituents at the time of their formation by sedimentation on the sea bottom. Clay has a peculiar affinity for petroleum or bitumen and will often be found charged with it in one form or another, especially where natant oil has come in contact with the banks of streams. Thus old clayey terraces, marking the margin of ancient water currents may be found to contain bituminous traces and to give forth feeble hints of gas, on account of oil transported, perhaps from a great distance, and imprisoned by the mere accident of contact.

All over the great Drift area of Indiana gas has been found in digging or boring for water. In most instances the reservoir was tapped before reaching the paleozoic rock. Of course, in each case the supply was small and the pressure feeble. Still the discovery would invariably be construed by the ordinary well digger to be promissory of a grand reservoir deeper down. The consequence has been the expenditure of a great deal of money and labor in vain. Gas can not pass through a heavy bed of

compact bowlder clay, nor through a dense stratum of argillaceous shale. Hence, a "pocket" of gas may exist in the midst of the Drift mass, or within a shale deposit, without at all indicating any supply deeper down. With the foregoing facts in mind, if we should bore entirely through the Drift and immediately upon reaching the paleozoic rocks we should find gas, we might be justified in expecting to reach a reservoir further down, more especially if we knew, from the geology of the region, that a formation otherwhere gas-bearing lay at no great distance beneath the drill, with clay shale intervening. In other words, the conditions would strongly indicate a gas-leak from a reservoir somewhere deeper in the earth.

At Findlay, in Ohio, however, such a leak extended through the entire Drift-mass, and the gas was utilized long before any of the now celebrated Trenton bores were made. Still, the rule and not the exception must govern. Marsh gas, fire-damp and natural gas are one and the same thing, and have the same sources of generation, namely: Decomposition of animal and vegetable matter. Old silted-up stream channels in our Drift deposits contain considerable amounts of plant remains and, perhaps, of animal matter also; hence, it is easy to account for a limited accumulation of carbureted hydrogen in such places. Superficially, these filled-up and abandoned stream beds are sometimes marshes giving rise to springs, through which the gas finds exit with feeble bubbling or boiling of the water. Of course, even the feeblest leak from the earth surface, of the character described, may indicate high pressure natural gas in a great reservoir far below, but the chances of this are so slight that they are not worth considering.

It may be set down, therefore, that there are no valuable accumulations of natural gas in the Drift mass, and that from the nature of the structure of our bituminious shales the gas they bear probably can not be collected into reservoirs great enough in extent to furnish a desirable supply, and that, therefore, surface indications in connection with either of these formations are deceitful and valueless, and that all the reservoirs of gas will be found below them.

It is well, perhaps, to remark just here that the "subterraneous reservoirs" mentioned in this paper are not vast, open caverns filled with oil or gas, but are merely porous strata into which these substances have been forced by the operation of their own gravity as compared with that of some other fluid or liquid, or by reason of hydrostatic pressure, or of capillary energy, or of all these combined. In the case of the Western Ohio gas the reservoir is, according to Professor Orton, a well defined formation of magnesian limestone. If, however, gas should be discovered leaking from the carboniferous rocks in the western or southwestern part of our State, it might be a good indication. I say "it might be," for all the features of the situation would have to be carefully considered in connection with a more definite statement of the probabilities. So, if surface

indications, very much like those which preceded the discovery of gas at Findlay, Ohio, were observed anywhere in Northern Indiana, I should say that a bore should be made there at once.

There are considerable disturbances of a peculiar and interesting nature affecting the paleozoic strata underlying the Drift of Northern Indiana, but at present their extent can be inferred only from certain conditions observed near Kentland, Delphi, Logansport, Huntington and Wabash. Further examinations may disclose a condition of things making the existence of gas in parts of that area quite probable, but at present nothing may confidently be said on the subject further than that there are some good reasons for believing that a thorough test might result successfully. Indeed, the existence of high pressure gas in the Lower Silurian rocks of Northwestern Ohio is owing to just such disturbances of the strata as are indicated by certain visible features of the same formation in our own State, and when we consider that the successful wells at Findlay, and other Ohio points, led to the discovery of the hidden folds of deep strata in which the precious substance had been collected, we may go forward with prudent and well-directed explorations, feeling that, at least, there need be no great loss, and that, if success should come, the results would be almost incalculably valuable.

In conclusion, it must be said that surface indications are not to be trusted, especially within our Drift area, and that if high-pressure gas be found anywhere within the limits of Indiana, it will most likely be in connection with accidents or disturbances of the rock structure which are so hidden by Drift as to be discovered in no way save by the patient investigations of science, or by the expensive operations of experimental boring. This boring should be done with great care and caution, and not till after there has been an exhaustive study of all the facts within reach should it be said that .ndiana has no vualuable deposits of oil or gas.

GAS IN INDIANA.

Since the foregoing report was made ready and a part of it published in the Indianapolis papers for the benefit of the public, natural gas has been reached at several points in Northern Indiana. A bore at Eaton, in Delaware County, and one in Kokomo, Howard County, struck a reservoir in the Trenton limestones under surroundings very similar to those of the Ohio wells. The flow at Kokomo at this writing indicates a good pressure and a probability that the supply is great; that at Eaton appears to be less promising, but not by any means discouraging. Owing to the fears entertained by the owners of the wells that the piping might be blown out the gas has not been confined in either of them, consequently no accurate measurement of either flow or pressure has been made. I hope to be able to present these facts before this report goes to press, though but few days are left to wait for them.

Dr. A. J. Phinney, of Muncie, who has proved himself a very able and painstaking assistant, makes the following report of the facts in connection with the well at Eaton:

THE EATON GAS WELL.

"This well was first bored in 1876 to a depth of 600 feet, at which point a flow of gas was obtained sufficient to produce a flame two feet in hight. A diamond drill was used and the hole was only two inches in diameter. As the company was exploring for coal, no attention was paid to the gas as it was not thought at that time to possess any economic value. Since the discovery of natural gas at Findlay, and other points in Ohio, those formerly interested in the Eaton well became convinced that gas would be found in paying quantities at that point. This opinion, of course, was based upon the fact that gas had been found previously. Among those most sanguine of success were George W. Carter, of Eaton; W. W. Worthington and Robert Bell, of Fort Wayne. These gentlemen, together with the wide awake and enterprising citizens of the town and surrounding country, organized the present company, and work was begun at once, Mr. A. H. Cranell having the contract. The hole has a diameter of eight inches for the first 250 feet, the balance five and one-half inches; hight of derrick, 72 feet.

Gas was found at a depth of 922 feet after having passed through the following strata:

Buff limestone	5 ft.	Niagra.
Blue limestones	20 ft.	
Yellowish limestone	30 ft.	
Bluish-gray limestone	45 ft.	
White limestone	35 ft.	
Bluish argillaceous limestone	55 ft.	
Buff limestone	10 ft.	Clinton.
	200 ft.	
Argillaceous limestone, drab, lower half gradually becoming darker until quite black	690 ft.	Hudson River group and Utica shale.
Buff limestone	32 ft.	Trenton.
Total depth	922 ft.	

The lower portion of the 690 feet of argillaceous limestone I consider the equivalent of the Utica shale of N. T., though not so black here as at its outcrops in Canada or as found in the wells at Findlay or Bluffton.

Below I give a rough section of the Bluffton well, given me from memory by Mr. Cranell:

Limestone	350 feet	Niagara.
Gray and blue limestone	300 feet	Hudson River.
Black shale	400 feet	Utica shale.
Trenton limestone, darker than Eaton, full of salt water	150 feet	Trenton.
	1,200 feet	

From the above the Niagara will be seen to be 150 feet thicker than at Eaton. No gas was found in the Bluffton well.

The gas has some odor, though not very unpleasant; it burns without smoke, and is thought to be free from sulphur. The roar produced by the escaping of gas can, under favorable conditions, be heard at a distance of two miles. A two-inch pipe was extended from an elbow at the top of the casing to a point 18 feet above the derrick, or 90 feet from the ground. Another two-inch pipe was extended horizontally from the elbow about 60 feet from the well. Both pipes were furnished with a T, giving four places for the escape of the gas. When lighted the flame from each was about 10 feet long. The light could easily be seen from Muncie, twelve miles south, and I was told it had even been seen twenty miles. At the time of my visit, the derrick and the vertical pipe had been removed and the gas was all escaping from the horizontal two-inch pipe. Though the day was very windy, the flames were from 15 to 20 feet in length. The heat from the burning gas is perceptible for at least 60 feet. Mr. Cranell kindly allowed the gas to escape through a two-inch opening at the top of the elbow after having turned it off from the horizontal pipe. The force of the escaping gas was considerable, though one could force his hand down over the hole and hold it for a moment. The pressure, as it flowed from the pipe, is not probably over 10 pounds per square inch, though it would reach perhaps 150 pounds when confined. Work had just begun whereby the tubing is to be anchored to the rock; a gauge will then be put on and the pressure tested. The work of laying mains and fitting houses will soon be commenced, and in a short time this enormous waste will be utilized. The surface rocks, as shown in the quarry close by, have a slight westerly dip. There are no evidences of any arches in the strata. The rock is present in the bed of the Mississinewa River most of the way from Ridgeville, Randolph County, to the Wabash River, and it is probable that there is a slight dip of the strata to the north, sufficient to equal the fall in the river, as the same strata seem to be exposed as far down as Marion, Grant County. Of the conditions present in the Trenton rock nothing is known except that it is a very porous rock from the crevices and fissures out of which the gas escapes."

From what Dr. Phinney reports it will be seen that no local evidence of any disturbance of the rock is observable in the region of Eaton; but

of course there is as yet no way of determining whether or not the Trenton deposit has been subjected to disturbance. All along the line of the Wabash River, as is otherwhere shown, there is ample proof that the Silurian strata have been affected by upheavals, and there are features of the outcropping rocks at Kokomo pointing in the same direction, as will be seen by reference to Professor Gorby's report upon the Wabash Arch, where the occurrence of vertical breaks or seams in the strata are recorded. It is not likely, however, that a series of low anticlinal ridges or knobs, like those reaching from Northern Ohio across Indiana, would afford any such evidence of their existence as could be detected with any certainty in such limited exposures of the rocks as occur at Kokomo, or anywhere in Howard or Delaware counties.

From the workmen at the Kokomo gas well the following section was obtained:

Limstone (Devonian and Silurian)	434 feet.
Bituminous shale, dark	470 feet.
Cherty rock	4 feet.
White sandrock (?)	4 feet.
Cherty rock (whitish limestone)	4 feet.
Whitish limestone (Trenton?)	4 feet.
Total	920 feet.

This section I did not regard as reliable, and from specimens of the borings and the depth at which each was reached, the following would appear to be nearly correct:

Silurian limestone	300 feet.
Bituminous shale (Hudson River and Utica)	590 feet.
Brownish-gray limestone (Trenton)	2 feet.
Whitish or buff limestone (Trenton)	15 feet.
Grayish magnesian limestone (Trenton)	13 feet.
Total	920 feet.

One fact would seem to be settled at least, which is, that the Ohio gas field, so-called, reaches into Indiana, and that the Trenton limestone, in the northern part of our State, is the great reservoir of the precious substance. I see no reason to modify, as yet, the statements of the foregoing report made long before our gas was reached. The northern and northeastern parts of the State are the most promising fields for exploration. The dip of all the paleozoic strata of Indiana, as a rule, is westerly or south-westerly. This fact of itself makes the accumulation of gas and oil possible at any point where a porous stratum is obstructed by impervious matter, for, as I have said, oil flows downward and gas upward, and wherever this flow is obstructed there the substance will accumulate. At Kokomo the outcropping strata are oil-bearing to a considerable degree, and the shales are extremely bituminous, so much so, indeed,

that they have been burned for fuel in furnaces. This, to my mind, shows the source of the gas. Long ago the oil from these upper strata found its way down to a much lower level in the rocks where, by a process of distillation or chemical change, it was converted into gas which rose until it found its reservoir in the porous magnesian limestone of the Trenton formation.

I am aware that many objections can be urged to this theory, but I can not take space or time here to meet them in advance.

KOKOMO GAS WELL NO. 2.

The success attending the boring of the first gas well at Kokomo naturally created considerable excitement in that city and vicinity, and immediately a number of companies were organized at that place and others in the surrounding towns with a view of making similar experiments. The Kokomo Natural Gas and Oil Company, the successful projectors of Well No. 1, immediately set their drill to work at a point about one-fourth of a mile southwest of the first well, where, at the depth of 916 feet, a flow of gas was obtained greatly exceeding that from any well hitherto bored in Indiana.

The following article, clipped from the *Kokomo Dispatch* of December 23, 1886, gives the main facts in connection with Well No. 2:

"The *Dispatch* a short time since published an exhaustive history of petroleum and natural gas ventures in Howard County. The first effort was made by the Kokomo Petroleum and Mining Company in 1866, when a well was sunk southwest of the city to a depth of 825 feet and abandoned. The Howard Natural Gas and Oil Company will reopen the abandoned well next spring. From that time until September 13, 1886, derricks were unknown and no drill punctured the vigin soil. On that day the Kokomo Natural Gas and Oil Company began drilling on the land of A. F. Armstrong, just across Wildcat Creek at the foot of Washington street. At a depth of 904 feet Trenton sand rock, the upper shell of the gas bed, was reached. October 6, at 2:30 P. M., having drilled four feet through the Trenton, a small vein of gas was struck in a porous white sand rock, and at 1 o'clock the following morning, after puncturing the white sand four feet, a good volume of gas was developed. The drill was sent down thirty feet further, opening a strong vein of artesian water. At a total depth of 946 feet the well was packed, a separator put in to divide the gas and water, and the gas from Well No. 1 has since been flowing without the slightest indication of diminished volume.

THE SECOND WELL.

"No. 2 was located on the Armstrong land about 1,000 yards south-west of No. 1 and the drill started on November 16, and the work was continued up to 3:30 P. M., Friday afternoon—about 31 days—much delay being caused by the breaking of machinery and a defective boiler. The geological showing of the well did not differ, until the Trenton was struck, from No. 1, which was as follows:

Upper Silurian and Devonian limestone	434 ft.
Lake Huron shale*	470 ft.
Trenton	4 ft.

"At No. 2 the Trenton was struck at a depth of 905 feet. At 8:30, Friday morning, a flow of gas many times stronger than the first find in No. 1 was reached at a depth of 916½ feet. The news spread rapidly and many persons braved a blinding snow storm to reach the well. The flow increased steadily as the drill went down, and at noon the pressure was forcing bits of stone and pebbles from the well and tossing them high in the air. At 2 o'clock the sand pump was sent down, coming up dry as a bone. At 3:30 o'clock the tools were withdrawn for the last time, 924 feet having been attained. A few moments later the explosion detailed in another column occurred. In the fire that followed the rope mooring the drill was burned away, and it, with 900 feet of cable, went crashing to the bottom of the well. It is thought that it punctured the thin stratum forming the bottom shell of the gas bed and dividing it from the artesian water vein. The well is spouting water in about the same quantity as No. 1. However, the artesian water is a good thing; it does the gas no particular harm, since it can be perfectly separated, and as we can't have too much of a good thing, we can endure the water with singular good grace if necessary. The contractors believe that they can pack the water entirely out and make No. 2 a dry well. In the event they should fail in this, the gas and water will be piped to No. 1 and run through the separator. The flow is estimated to be from two to five times greater than that of No. 1. The drill and cable yet in the hole necessarily in some degree weaken the pressure, yet, seen after the wreck Friday night, a flame 30 feet in circumference was ascending from the six-inch casing to a hight of 50 feet.

"The formation in which gas was found in No. 2 differs somewhat from that of the first well. Below the Trenton stratum, instead of a bed of white sandstone is a ledge of porous rock or a bed of coarse gravel about eight feet in thickness.

"The gas was extinguished Saturday morning by forcing a T of casing over the hole. A new derrick is being built, and the work of casing and

* Hudson River and Utica shale.

packing the well will be immediately begun. The company has contracted for a third well, to be sunk at once upon a site not yet chosen. They have more than enough gas to meet all present demands, and their future wells will doubtlessly be sunk only to the Trenton shell and held for emergencies or increased demands on service. The logic of economy at least would suggest this course, unless the purpose is to prospect for oil, which has a precedent in the gas fields of Ohio and Pennsylvania.

"Mains have been laid from well No. 1 north on Washington Street to Mulberry, east on Mulberry to Main, south on Main to Sycamore, and west on Sycamore to Washington. Work will be pushed rapidly forward north on Washington to Jefferson, and west on Jefferson to the Spring Mills, and before spring this company, and the South Kokomo Company as well, will have many miles of mains in the ground. Gas is already being furnished as fuel to the natural gas companies' boilers and those of the Kokomo Gas Company and Electric Light Company. Many business houses and residences will at once be fitted for its use, and as soon as regulators are placed upon the wells, service will be furnished to those along the line of mains now laid. All mains have been tested to a pressure of twenty-five pounds, and a mean pressure of one-half pound will be carried. Three stoves and a grate furnished with gas have been on exhibition at the hardware store of Armstrong, Landon & Co. the past week. The test is highly satisfactory. The temperature is unvarying, and a genial warmth permeates the remotest corner of the vast room, while the entire absence of dirt, ashes and smoke is most favorably commented upon.

SOUTH KOKOMO COMPANY.

"The South Kokomo Company resumed work Monday morning, after a week's delay, with a new boiler at their rig. They are making good speed at a depth of 500 feet, and will probably develop gas Saturday. This company has a carload of mains on hand and will begin laying them immediately after gas is struck. With the second company almost at the goal, the third almost ready to begin work, the fourth organized and preparing to contract, and companies innumerable in *prospectu*, the consumer's interest can not but be served. And it is not straining the aphorism that "competition is the life of trade" to believe that the competition will work to the benefit of the companies, the consumers and the city at large, in that the companies will hasten the endeavor to secure the location of foreign interests to consume their vast over-supply.

THE JUNCTION COMPANY.

"A meeting of the stockholders of the Junction Company was held yesterday, at Harris's furniture store, and the contract for the first well closed with Messrs. Laney & Churchill. The well will be sunk near the Junc-

tion, but the exact location has not yet been determined upon. The derrick will be put up at once, and drilling will begin as soon as the machinery can be placed."

The flow of gas from Well No. 1 is estimated by Mr. McNeill, who has had a long experience in the manufacture of artificial gas, at from 1,000,000 to 1,500,000 cubic feet per day. He estimates the flow from the second well at from 4,000,000 to 5,000,000 cubic feet daily. There has been no perceptible diminution of the flow of gas from Well No. 1 since the well was developed on October 6. Neither was it affected in the least by the developing of the second well.

CHARACTER OF THE GAS.

No analysis has as yet been made of the gas from the Kokomo wells, but it is quite likely to prove to be nearly identical with the gas found at Findlay, Ohio; probably, however, showing a much higher per cent. of sulphureted hydrogen. The odor of this gas was very strong from both the wells at the beginning of the flow, but it gradually diminished until it is scarcely more perceptible than in ordinary coal gas. At the beginning of the flow small "sulphur balls" were continuously being forced out of the pipe by the flowing gas, but with the continuation of the flow the escapement of these small particles gradually diminished until at present none are noticed. The concretionary appearance of these sulphur particles indicates that they were formed by precipitation in the cavity near the bottom of the tubes or pipes.

It is quite evident that the flow of gas is obtained from the Trenton limestone. The so-called "sand" consists of small calcareous particles resembling silicious sand, which consist, however, of a large proportion of carbonate of lime. The stratum from which the gas flows varies from a nearly pure white to a darkish gray color. The stone is porous and somewhat concretionary in structure. The stratum from which the gas flows seems to be perfectly dry, containing no water nor evidence of petroleum.

While the rock deposits about Kokomo are generally covered by deep accumulations of Drift, the few exposures that may be examined show considerable evidence of disturbance at some remote period. Though not tilted to any considerable degree, they appear to lie in great folds, or wave-like masses, consisting of alternating anticlinal ridges and synclinal troughs or valleys. These phenomena are probably due to the same causes that produced the tilted and distorted condition of the rocks at various points described in the paper on the Wabash Arch. Since the oil and gas fields of Western Ohio are embraced in the area subjected to the Wabash disturbances, it seems that bores for oil and gas might be made with some degree of confidence at points intermediate between Kokomo and the Ohio gas fields.

GAS WELL NO. 3, KOKOMO.

Gas well No. 3, at Kokomo, was drilled into the Trenton limestone on December 28, 1886, and the following letter from Mr. John T. Stringer, received just as this article goes to press, contains all the important facts pertaining to it:

KOKOMO, IND., December 31, 1886.

S. S. Gorby, Esq., Indianapolis, Ind.:

DEAR SIR—Mr. John E. Moore hands me your letter of inquiry. With pleasure I answer:

Depth of well	912 feet.
Drift	5 feet.
Limestone	400 feet.
Huron shale*	498 feet.
Trenton limestone	4 feet.
Total in Trenton after striking gas	5 feet.
Total	912 feet.

Our well is not anchored yet, hence we can not get a full test beyond one hundred pounds. The steam gauge runs to one hundred pounds in two minutes. The estimates given of quantity, by a gentleman familiar with and owner of wells in Pennsylvania, is 4,000,000 feet per day.

I think the smell of sulphur was less than that observed in wells Nos. 1 and 2 when first struck.

Respectfully,

J. T. STRINGER,
Secretary South Kokomo Gas Co.

The gas-bearing rocks are reached in all the Kokomo wells at the depth of about one hundred feet below sea level.

THE KOKOMO ARTESIAN WATER.

A strong flow of water, containing valuable chemical qualities, was obtained from wells Nos. 1 and 2, at Kokomo. No complete analysis of this water has yet been made, but Dr. Moulder, of that city, made a partial analysis which shows that, as a remedial agent, the water of the Kokomo wells will undoubtedly achieve the popularity of the well-known waters of Lafayette, Lodi, French Lick, and other points.

The following statements, with Dr. Moulder's analysis, were clipped from the *Kokomo Dispatch:*

"There are over sixty grains of mineral matter to every pint of the water, held in solution in such proportions as to make a drinking and bathing water with an exhilarating influence, and a very valuable remedy in

* Hudson River and Utica shale.

treating debility, languor, rheumatism, diseases of the kidneys, liver, skin, stomach, headache, cancer, syphilis, gout, running sores, scrofula, etc., and will, when properly understood and applied, produce cures that will be miracles.

"Every pint (of sixteen ounces) of the water contains the following valuable minerals held in solution in such a manner as to make a pleasant and very palatable drinking water, and hundreds of our people already are loud in its praise for what it has done for them, some almost marvelous cures already having been reported of kidney, liver and stomach diseases:

ANALYSIS.

Specific gravity	1010

MINERALS.

Sodium Chlorate (about)	26 grains.
Magnesium Chloride (about)	2 grains.
Potassium Chloride	traces.
Sodium Sulphate	2 grains.
Oxide of Iron	3 grains.
Magnesium Iodide	3 grains.
Magnesium Sulphate	3 grains.
Calcium Sulphate	10 grains.
Calcium Chloride	traces.
Petroleum	traces.

GASES.

Sulphureted Hydrogen.
Nitrogen
Oxygen.
Carbonic Acid.

"There may also be other remedies held in solution that will prove to be as remarkable as the ones that have already been detected by analysis. The water is as clear as crystal and is quite pleasant to the taste, being noticeably charged with chloride of sodium, or common salt. The smell or odor is that of sulphureted hydrogen, but not so pronounced as the artesian water at Lafayette or the water of Lodi. All scientific and medical men, who have examined the water, give it as their opinion that it is a valuable find of wonderful remedial chalybeate water. One can not drink too much of this water or suffer any inconvenience from frequent and copious draughts. Its effect is mildly cathartic and pleasant. A fondness for it grows on a habitual drinker, as is the case with all mineral waters."

The water rises in the pipes to a hight sufficient to distribute it over every portion of the city, and it is the design of the city authorities to erect suitable fountains at convenient points for the accommodation of the public.

THE MUNCIE GAS WELL.

Gas well No. 1, at Muncie, is located about one mile east of the city. The elevation above sea level at the well is about 975 feet. The total depth of the well is 898 feet. The following is the section of the well:

SECTION OF MUNCIE GAS WELL NO. 1.

Niagara limestone and shales	265 ft.
Hudson River limestone and Utica shales	611 ft.
Trenton limestone	22 ft.
Total	898 ft.

The gas at this well, flowing through a two-inch pipe, has a pressure of 325 lbs. per square inch. Mains are being rapidly laid throughout the city, and the gas is rapidly coming into use for domestic and manufacturing purposes.

The odor of sulphureted hydrogen is scarcely preceptible. The gas burns with great brilliancy, creating an intense heat. By a simple and cheap arrangement, in the form of a burner, any heating or cooking stove can readily be adapted to its use. The price of the burner is only eighty-five cents. For lighting purposes it has been found, upon thorough tests, to be fully equal to artificial gas. It does not require to be refined.

Well No. 2, bored about one-fourth of a mile north-east of the city, has reached a depth of 1,020 feet, and at the date that this paper goes to press, January 7, 1887, no gas nor petroleum has been found. The drill is now at work in the sandstone underlying the Trenton rocks.

THE TIPTON GAS AND OIL WELL.

Soon after the discovery of gas in paying quantities, at Kokomo, a company was organized at Tipton, twenty miles south, under the title of "The Tipton Mining and Exploring Company." This company began operations early in December, and sunk their first well in the northern part of the city.

A slight flow of gas was obtained from the Trenton limestone, at a depth a little greater than 1,000 feet. A few feet lower down a "flow" of petroleum was obtained, and a strong vein of water at 1,030 feet.

The following section of the well was obtained:

SECTION OF TIPTON GAS WELL.

Drift material	139 feet.
Limestone, varying in color and texture	326 feet.
Limestone and shales	532 feet.
Limestone (gas-bearing)	11 feet.
Limestone (oil-bearing)	3 feet.
Limestone to water	19 feet.
Total	1,030 feet.

The accumulation of petroleum in the bore is estimated at from three to five barrels per day.

The probabilities are very strong that gas will be found in paying quantities at this point, and the prospects for petroleum in the vicinity are very encouraging. Other wells will be sunk soon.

The following report, kindly handed in by Dr. R. T. Brown, shows the results of the work to date in the experimental well at Indianapolis:

Hon. Maurice Thompson, State Geologist:

DEAR SIR—At your request I submit notes of the boring in progress in this city in charge of the Indianapolis Gaslight and Coke Company:

Surface Drift—gravel, sand and clay	118 ft.
Devonian limestone	68 ft.
Coarse sandstone (Oriskany)	20 ft.
Niagara limestone and shale	694 ft.
Trenton (Cincinnati) limestone	620 ft.
Total	1,520 ft.

At the base of the Trenton a bed of firmly compacted sand was encountered, in which the drill became detached, and more than a month has been spent in efforts to recover it. It is the intention of the company to sink the boring to the depth of 2,500 feet, unless a supply of gas is sooner obtained.

Copious streams of water, highly charged with sulphureted hydrogen, were encountered at 200 and 900 feet, but neither rose to the surface.

R. T. BROWN.

INDIANAPOLIS, Jan. 4, 1887.

PORTLAND GAS WELLS.

An attempt was made to find gas at Portland during the summer of 1886, and although a flow was obtained it was so slight as to merely ignite with a feeble flash, and be immediately extinguished. The first well was bored to the depth 1,440 feet, passing entirely through the Trenton limestones, and for all practical purposes was, of course, a failure. A second attempt, however, has recently resulted in marked success, securing a flow with a pressure of 298 lbs. per square inch, and, as at Muncie and Kokomo, the gas is rapidly being adapted to the various uses throughout the city to which it may be applied. The following is a section of the second well:

SECTION OF GAS WELL NO. 2, PORTLAND.

Drift	58 ft.
Niagara limestone	192 ft.
Hudson River limestone and Utica shale	740 ft.
Total	990 ft.

The elevation at the well is a little more than 900 feet above sea level.

THE ARTESIAN WELL, BLOOMINGTON.

Under date of Jan. 11, 1887, Mr. Wallace Hight, of Bloomington, forwarded to this office the following section of the Artesian well at Bloomington, which was bored at the joint expense of Monroe County and the city of Bloomington. It was the original intention to continue the boring until the depth of 3,000 feet was reached, but the pumps became fastened in the well at the depth of 2,730 feet, and the work was abandoned. The following is the section:

SECTION OF THE ARTESIAN WELL, BLOOMINGTON.

Earth	6 ft.
St. Louis limestone, water	30 ft.
Keokuk limestone	89 ft.
Knobstone	630 ft.
Red shale	20 ft.
Blue limestone	5 ft.
Brown shale, gas	10 ft.
Black slate, Devonian	120 ft.
Gray limestone, Portland cement	15 ft.
Brown limestone, Niagara	240 ft.
Shaly limestone	15 ft.
Light-brown limestone	130 ft.
Flinty limestone	30 ft.
Light-colored limestone	100 ft.
Brown limestone	70 ft.
Blue shale	40 ft.
Blue limestone	40 ft.
Blue shale, streaks of limestone	60 ft.
Blue shale	180 ft.
Grey limestone, some shale	586 ft.
Blue shale	40 ft.
Hard, white sandstone	4 ft.
Shaly limestone and sandstone	20 ft.
Grey limestone and sandstone	20 ft.
Shaly limestone, sandstone and quartzite	98 ft.
White and yellow, hard sandstone, iron	22 ft.
White sandstone, softer	20 ft.
White sandstone, soft	40 ft.
Grey limestone and sandstone, mixed	42 ft.
Grey limestone, sulphur-water increasing rapidly	8 ft.
Total	2,730 ft.

The foregoing reports of the successful efforts to develop natural gas at the various points mentioned are necessarily brief and incomplete. In most instances the sections of the wells given are probably not strictly accurate, as no careful notes of the changes in strata were made as the work progressed.

This department has had very little opportunity to collect facts, as all of the matter intended for publication in this volume was already in the hands of the printer, and much of it already printed, before the operation of drilling had been commenced in the most largely productive wells. However, these facts, brief as they are, will be full of interest to many of our citizens, showing, as they do, that a new source of wealth, hidden deep in the reservoirs of the earth, is likely to open up in Northern and Eastern Indiana, and possibly in other parts of the State.

It is the intention of this department to carefully collect and preserve all the facts connected with these subterranean explorations, to the end that those who desire information on this subject may here obtain all the reliable data to be acquired within the State.